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THE EAST ANGLIAN EARTHQUAKE OF 1884

Report on the East Anglian Earthquake of April 22, 1884. By Raphael Meldola, F.C.S., &c., and William White, F.E.S. Drawn up by R. Meldola, and read in abstract at the meeting of the Essex Field Club, February 28, 1885. (London: Macmillan and Co.; and the Essex Field Club, Buckhurst Hill. 1885.)

FORTUNATELY for this country we have not been called upon to notice a report of such an earthquake as that which is chronicled in the volume before us since this journal came into existence. Indeed, the authors state that no shock approaching it in intensity has been experienced in the British Islands for at least four centuries. A brief notice of the occurrence was given in our columns (vol. xxx. pp. 17 and 60) by Mr. Topley, and we now have a complete scientific account drawn up by Prof. R. Meldola and presented to the Essex Field Club as a special memoir embodying the results of his investigation in conjunction with his colleague, Mr. William White. The book consists of about 225 pages of readable matter with four maps and numerous illustrations, and the Essex Field Club has certainly earned the gratitude of scientific men in enabling the authors to give publicity to this final result of their labour.

Earthquakes may be considered from three distinct points of view: dynamical, geological, and meteorological or cosmical. The first deals with the purely mechanical aspect of earthquake motion, the second with the immediate cause or causes of these disturbances and their effects as determined by geological conditions, while the last, which is at present the most obscure branch of the subject, deals with the periodicity of earthquakes and their connection with other natural phenomena. The present shock is dealt with from each of these stand-points.

Of the eight sections into which the Report is divided the first is entirely historical, and the authors give a catalogue of all the British earthquakes which have produced structural damage, the records commencing in A.D. 103 and ending with the Nottingham shock of 1881, which slightly damaged a building at Tackley. This list comprises about sixty records, and the authors acknowledge their indebtedness to Mallet's British Association Catalogue, which has greatly facilitated their work of compilation. One very interesting circumstance brought out by this part of the inquiry is that the seat of the present earthquake has been exceptionally free from seismic disturbance since the beginning of authentic history, and it further appears that there have been altogether only about half-a-dozen shocks in Britain since this period which can be compared in their destructive effects with that of 1884.

The second section gives a brief description of the preparation of the Report and the methods adopted for securing the most complete and trustworthy information as soon as possible after the event. Amongst those to whom the authors express their obligation are Mr. G. J. Symons, F.R.S., who had himself made a personal inspection of the scene of damage the day after the shock,

and Mr. J. C. Shenstone, of Colchester, who appears to have supplied much valuable local information.

Under the third section, which is headed "General Characters of the Disturbance," we have a statement as to the extent of the shock, which brings out very forcibly the unpleasant fact that our little island is not quite so "tight," as the popular song would have us believe. It seems that the sensible vibrations extended over at least 50,000 square miles of country. An estimate of the intensity is also given which is compared with that of the great Lisbon catastrophe of 1755, the authors arriving at the conclusion that the present shock was about one-twentieth the intensity of the former. In support of the statement that "the earthquake occurred during a period of general seismic activity throughout the world" we have a list of all the British and the more violent of the European earthquakes which have occurred since the beginning of the year 1881. We need only remind our readers that during this period occurred the disasters in Ischia and Chios, the cataclysm in the Sunda Straits, and, more recently, the great Spanish earthquakes, all of which have already been noticed in our columns. With reference to the meteorology we are informed very explicitly that "the evidence is conclusive that no special meteorological conditions preceded, accompanied, or succeeded the disturbance of last April in direct relationship to that event."

In treating of the nature and duration of the movement, and other points of importance which find place in this third section, the authors give a concise account of the general characters of earthquake motion as derived from the observations of modern seismologists, and especially from those made in Japan by Profs. Milne and Ewing, to whose labours constant reference is made throughout the Report. The following conclusion, supported by observations made at Heybridge and Ipswich, is arrived at:—

"There is every reason to believe that the earthquake with which we are dealing was precisely similar in character to those frequent shakings which have been so thoroughly studied in the Plain of Yedo. As in the case of the latter, if our earthquake had been made to trace the story of its own movement on a series of seismographic plates, we should no doubt have seen the gradually commencing tremor increasing in amplitude and complexity till the 'shock' and destruction occurred, and then again dying gradually out."

In the fourth section we have a discussion of the nature and amount of the structural damage, from which it appears that in an area of fifty to sixty square miles damage was caused to 1213 houses and cottages, twenty churches, and eleven chapels.

The "Descriptive Report," which comprises the next section, occupies over 100 pages of the volume, nearly one-half of this portion being devoted to a detailed description of the observations in the area of structural damage made on the ground by Prof. Meldola, Mr. T. V. Holmes, F.G.S., President, and Mr. W. Cole, Secretary, of the Essex Field Club. Many illustrations of peculiar forms of damage are given, and there can be no doubt that the observations recorded in this section will be not only of local interest but also of use to engineers and others who occupy themselves with the important question of construction in earthquake countries.

In summarising this portion it is stated that "the main axis of disturbance extends on each side of a line about five miles in length, having a direction north-east and south-west from Wivenhoe to Peldon. Along this axis the greatest intensity was manifested, as shown by the large percentage of dislodged chimneys, dismantled roofs, &c., and more especially by the fracturing of solid masonry." Following this summary there are the complete records from other parts of Essex and all the other counties over which the disturbance extended. Among the former we notice a very full report from Bocking, furnished by Mr. E. B. Knobel, Sec.R.A.S. It is of interest also to observe how widely the shock was felt over London; records are given from every quarter of the town, and we can but feel thankful that the "axis of disturbance" was not nearer home, or the destruction to life and property would have been most disastrous. A glance at the map, giving the general distribution of the shock, shows that the vibrations were felt as far off as Altrincham in Cheshire, at Sidbury in Shropshire, Street in Somersetshire, Exeter, the Isle of Wight, and across the Channel at Boulogne and Ostend.

The next section will be of special interest to geologists. It is headed "The Earthquake in Relation to Geological Structure," and the first portion deals with the effects of the shock upon underground waters. These effects are, briefly, the raising of the water-level in deep wells near the origin, the falling off of the supply to surface wells, and the rendering turbid of the water derived from the Chalk at Canterbury and in surface wells nearer the centre of the disturbance. The records kept by the Underground Water Committee of the British Association have enabled the authors to give a most valuable series of measurements made at Bocking on behalf of this Committee by Mr. D. Radford Sharpe.

One of the most important practical considerations in connection with earthquake damage is the effect of the subsoil and the position of buildings with respect to the general physical features of the district. This branch of the subject is fully dealt with in the present geological section of the Report, and the authors point out that, owing to the circumstance of the shock having originated beneath a district consisting entirely of London Clay and drift deposits, no very definite conclusions can be drawn as to the effects of the superficial geology in determining the distribution of the damage. They incline to the view that the damage was increased in some cases by the situation of buildings at the junction of different formations, where, in accordance with well-known dynamical principles, the earth-wave undergoes reflection and refraction. A considerable amount of evidence is given to show that both in this and other earthquakes there is a tendency for the shock to make itself felt with special distinctness along "free margins, such as coast-lines, river-valleys, and lines of outcrop, because in these cases there is no resistance offered in one direction to the vibrating particles in their outward movements."

In connection with other geological considerations the authors state that their seismic axis corresponds in direction with the coast-line at this part of Essex, and this fact appears to be in harmony with the theory first put forward by Prof. J. P. O'Reilly. Several pages are devoted to a critical discussion of the evidence furnished by

the records from beyond the London Basin, from which it distinctly appears that the shock was spread outwards along the older rocks, owing to the superior "seismic conductivity" of these beds.

In speculating upon the cause of the earthquake the authors display great caution. Having dismissed the view of the shock having been due to volcanic agency they go on to say:—

"The most feasible explanation, in so far as it is safe to hazard any explanation at all, appears to be that of the sudden rupture of deep-seated rocks under a state of strain, the snap and shock accompanying such a fracture being quite competent to produce the effects observed. The precise formation in which this rupture may have occurred cannot even be conjectured; but the great extent of the shock, on the one hand, and on the other the absence of any perceptible change of surface-level, appear to point to a tolerably deep-seated origin."

It is then pointed out as a very significant fact that the axis of the present earthquake corresponds in direction with known faults or other disturbances in the Chalk beneath Essex, Suffolk, and Cambridgeshire, and with that of the well-known Deptford fault.

In the seventh section there are collected a number of miscellaneous observations which could not well find place in the preceding portions of the Report. Mallet's method of determining the "angle of emergence" by the cracks in buildings has been found useless in the present earthquake, and the authors wisely state:—

"We have not thought it advisable to give any calculations of the depth of the origin of the disturbance, being convinced that under the present circumstances such determinations would only give a fictitious semblance of certainty to the results."

A full discussion of the time-records is then given, and the mean velocity of propagation of 9183 feet per second deduced from the most trustworthy. The remainder of this section contains "Observations on Direction," "Personal Experiences of Direction," "Order of Succession of Phenomena," the "Direction as given by Clock-stoppages," and an important sub-section on the twists of chimneys.

The eighth and last section gives a general summary of the whole work. In a postscript, two observations of considerable interest are recorded, the first being the registration of the shock and subsequent earth-tilt at Leeds by a barograph, and the second the displacement of Mr. C. L. Prince's equatorial at the Crowborough Observatory in Sussex. The volume concludes with a short appendix, which relates to the list of British earthquakes.

SYSTEMATIC SMALL FARMING

Systematic Small Farming. By Robert Scott Burn. (London: Crosby Lockwood and Co., 1886.)

THIS volume may be divided into two parts. In the first few chapters the author shows, with considerable clearness, the disadvantages under which small farmers or peasant proprietors are placed. The topic is one which has recently been discussed in connection with legislative projects looming upon the political horizon, and Mr. Scott Burn has contributed towards its elucidation. "While he would be glad to see a limited